Sept. 22, 1936. E. B. HUDSON 2,054,819

APPARATUS FOR TENSIONED COLD ROLLING IN REVERSIBLE MILLS

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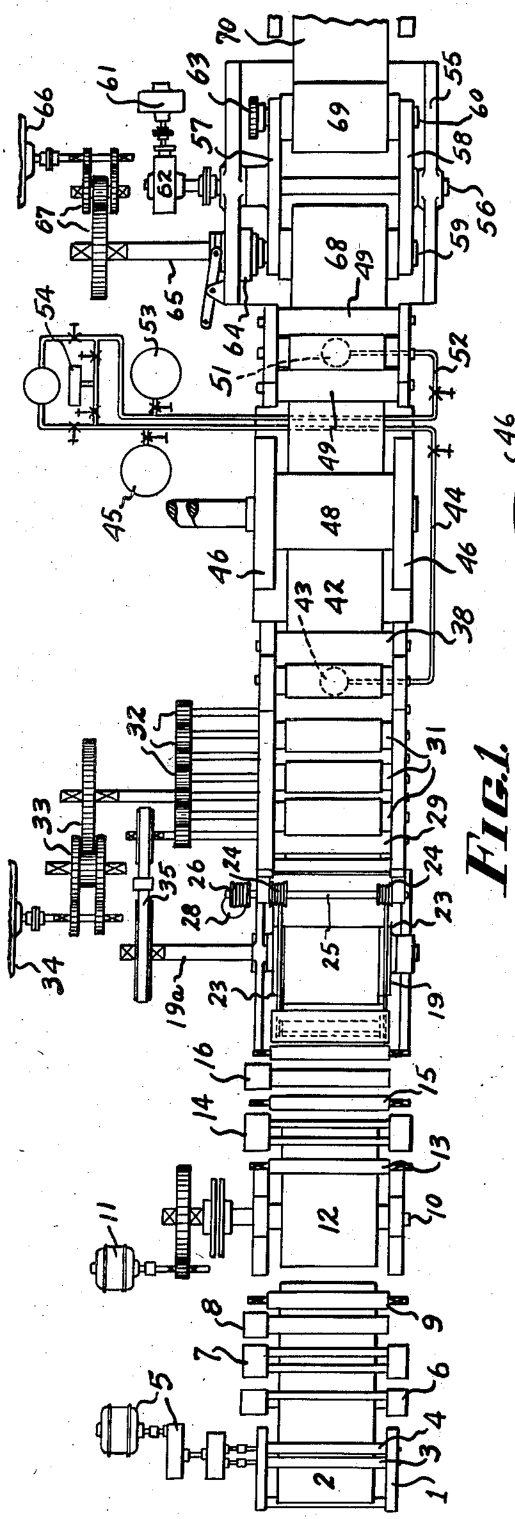

FIG. 1.

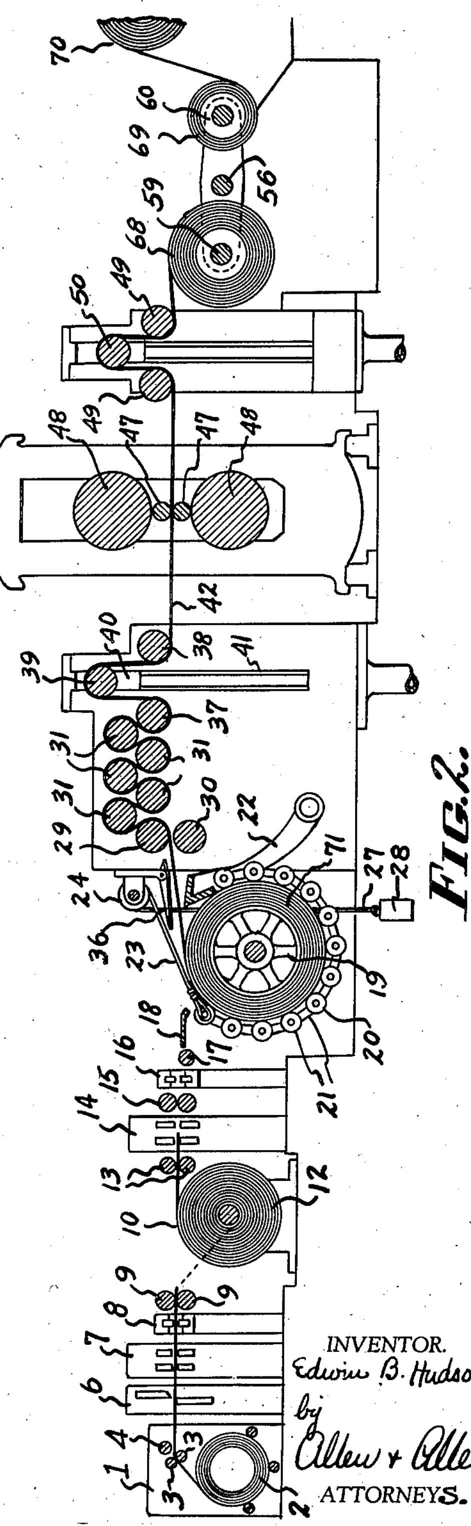

FIG. 2.

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APPARATUS FOR TENSIONED COLD ROLLING IN REVERSIBLE MILLS

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8 Claims. (Cl. 29—33)

It has hitherto been attempted to roll strip material of sheet width in reversible mills, usually of the four-high type, and also to apply considerable tension to the strip as it is being so rolled. Single stand mills of this general type have certain disadvantages in operation, however. They are limited in the production of tonnage, due primarily to conditions imposed by the hot mills upon which the strip sheets are made. These hot mills are able to turn out only relatively short coils, the usual length being about three hundred to four hundred feet. These short coils make it necessary to operate at relatively slow speeds, at least on the early passes. Another disadvantage of short coils is that the length of the strip sheet used up in fastening the strip sheet to the drums on either side of the mill amounts to a very considerable length of metal as compared with the length of the coils employed. This metal cannot be rolled because it cannot be caused to enter the mill; and as a consequence, it has to be either discarded or made into some other product. These unrolled ends, together with strip degraded by cobbles and breakage, amount usually to around three hundred pounds per ton of metal, and in the ordinary plant may represent as much as $50,000 loss per year.

The general objects of my invention are, to provide rolling apparatus of the reversible mill type capable of rolling thin metal gauge strips in larger quantities than is possible with the type of equipment hitherto in use; to provide a mill and associated apparatus which is economical in first cost and very economical in operating cost; to provide for the rolling of coils of metal which greatly exceed the length of the strip sheets furnished by the hot mill, and usually will be from ten to fifteen times as long, whereby the length of the coils furnished by the hot mill is not determinative of the length of the coils supplied to the cold mill; to provide means to insure the rolling of the greatest amount of strip with the minimum of scrap loss; to provide a way of eliminating unrolled portions of the strip or strip sheet; to provide means for permitting a greater surface speed of rolling; and to provide a system in which the portions of the strip being rolled may be maintained continuously under a predetermined constant tension so as to insure constant gauge reduction, and so as to maintain the stress in the strip safely below the breaking stress. My objects also include the provision of processes to the ends hereinabove set forth.

In a co-pending application entitled "Process and mechanism for rolling endless lengths of metal in reversible mills", Serial No. 741,133, filed August 23, 1934, I have set forth a method of rolling strips of endless lengths involving the segregation of a given portion of an endless strip for rolling purposes, and the rolling of this strip backwardly and forwardly through a reversible mill or series of mills until it is reduced to the desired gauge. When this has been accomplished the rolled portion of the strip is paid out, and an additional portion is segregated for rolling purposes. In this way the end scrap loss is eliminated. In my present case I do not keep the strip in an endless length during the rolling operation, but segregate a portion of it by severing that portion from the endless supply. In this way I do away with the necessity of apparatus for taking up unsevered lengths of the strip on either side of the mill, and can thereby reduce the quantity of apparatus necessary and the overall space taken up by the apparatus in general. But in this case I have also provided means and a method whereby the production of unrolled ends of the strip is eliminated, and scrap loss from this source is avoided.

Essentially in the practice of my invention, I take the strip sheets produced on the hot mill and weld successive strip sheets end to end until I have accumulated a large quantity of stock for rolling. This large quantity of stock, usually in the form of a coil of metal say of 25,000 lbs. in weight or more, is then passed through a reversible mill or series of mills backwardly and forwardly until it is reduced to gauge. On either side of the mill I provide means for maintaining in the strip constantly a predetermined tension of constant amount, and I also provide tensioning means and means in the nature of coiling means at either side of the mill or mills, to take up the strip during rolling as it is fed through the mills. In this way I produce at each operation of the mill a length of strip weighing say 25,000 lbs. or more, which has been completely reduced to gauge excepting for a relatively short portion at one end thereof as distinguished from unrolled portions at both ends of the strip in previous attempts to roll strip sheets on the reversible mill. Moreover, upon the succeeding operation of my mill this unrolled portion at the trailing end of the preceding strip is now rolled to gauge, so that I do away with scrap loss arising from this source.

Moreover, by the provision of large rolls of stock for rolling, I am able to increase the speed of the rolling operation. It has been found by experiment that high surface speeds during rolling have advantages other than higher tonnage. Lower mill screw pressures may be used, and the strip work hardens at a slower rate, due to the temperature developed in the strip by cold working at a very rapid rate. The strip has less time to radiate its developed heat between the various passes, or between the pass and the coiling point, so that the strip enters the following pass or passes at a higher temperature. This aids in its reduction.

These various objects of my invention, and others which will be set forth hereinafter, or will be apparent to one skilled in the art upon reading these specifications, I accomplish by that certain construction and arrangement of parts and in that process of which I shall hereinafter set forth an exemplary embodiment. To facilitate a disclosure of this embodiment, reference is now made to the accompanying drawing, wherein—

Figure 1 is a plan view of a single stand reversible mill embodying my invention.

Figure 2 is an elevational view thereof, with parts in section.

I have indicated at 1 a decoiler in which a strip sheet coil 2 may be supported and unwound, the pinch rolls 3 and knee roll 4 serving to decoil and somewhat straighten the metal. The decoiler is operated by a prime mover and suitable drive indicated generally at 5. The strip next passes to a shear 6, where the leading end thereof may be squared to facilitate the formation of a butt-weld joint to the trailing end of a preceding strip. A welder is indicated generally at 7, which may be of any suitable type, preferably, though not necessarily, an electrical butt-welder. A flash cutter is indicated at 8, the purpose of which is to remove from the weld any portions of the metal which extend up above the general plane of the surfaces of the strip sheet. Pinch rolls 9 serve either to hold or to pay out the metal.

By the juncture of succeeding coils to a supply of strip sheet, rolling material is accumulated upon a reel 10, which may be driven by a suitable prime mover 11. Ordinarily in the practice of my invention, I accumulate upon the reel 10 a coil of metal weighing 25,000 lbs. or more, and consisting of one large coil say of 3500 to 4000 feet in length. This coil I have indicated at 12.

I have shown pinch rolls 13 lying beyond the coiler 10, and beyond this a welding device 14, pinch rolls 15, and a flash cutter 16. In this group of apparatus a shear may be included, if desired. Beyond the flash cutter 16 I have shown a supporting roll 17 and a table 18.

I have next shown a type of coiling device which I refer to as a friction coiler. This comprises a smooth drum 19 with means for driving it, which will hereinafter be described, and a flexible outer sheath member of chain form comprising rollers 20 and interconnecting links 21. This outer sheath is supported at one end by a pivoted member 22, and is caught at its other end by cables 23 which pass over drums 24 on a shaft 25. This shaft bears at its end another drum 26, to which a cable 27 is attached. A weight 28 is fastened on the end of the cable. The operation of this weight is to tighten up on the sheath member which, since its other end is fastened to the pivoted member 22, is able to conform to the surface of coils of varying size upon the drum 19.

I have shown a deflector or guide member 36, the function of which is to guide the end of a strip into the friction coiler. The strip may be thought of as coming into the coiler from the right in Figure 2. When the coiler is empty, the sheath member comprising elements 20 and 21 encircles the drum 19, and the action of the deflector 36 is to lead into this cradle the end of the sheet, so as to wrap it about the drum 19. Thereafter the sheath functions to keep the strip tightly wrapped about the drum, irrespective of the size of the coiler. The deflector member 36 may be actuated in any way desired, either manually or automatically, as by means of a fluid pressure cylinder with suitable controls.

The next piece of apparatus is a continuous pulling device comprising pinch rolls 29 and 30, and a series of rolls 31 which are arranged in staggered relationship, and about which the strip passes sinuously. The purpose of the pinch rolls 29 and 30 is to keep the strip tightly in contact with the rolls 31, which are rolled through a suitable gearing indicated generally at 32 and 33 from a prime mover 34. These rolls therefore exert a tension upon the strip as it passes through them, as will be readily understood, and this device, which I shall hereinafter refer to as a continuous puller, is of a type set forth in my co-pending application Serial No. 668,100, filed April 26, 1933.

I have shown the shaft 19*a* of the drum of the friction coiler driven by a belt 35 from a pulley driven by the prime mover 34. This particular drive is, of course, not essential but I have indicated it as setting forth a type of slip drive to compensate for changes in surface speed due to the growth or diminishing of a coil of metal in the friction coiler, as will be well understood.

The last roll 37 of the continuous pulling device, serves also as one of the knee rolls of a static tension applying device. The other knee roll is indicated at 38, and a pull roll 39 is also shown mounted on a bearing member 40 which operates in ways 41 in the framework supporting the aforesaid rolls. In the particular embodiment illustrated, the strip indicated at 42 is shown passing under the knee rolls 37 and 38, and over the pull roll 39, although this particular method of threading is not a limitation upon my invention. The roll 39 is urged upwardly by the action of a hydraulic cylinder indicated at 43, connected by a conduit 44 to a hydraulic accumulator 45. This accumulator can be loaded in such a way as to cause the pull roll 39 to exert a continuous force upon the strip 42. If, due to sporadic changes in rolling conditions, the strip 42 becomes shortened or elongated in that portion of it which extends between the continuous puller and the mill next to be described, the tension in the strip will nevertheless not change, but the roll 39 will move upwardly or downwardly, with or against the force of the hydraulic cylinder, to allow for these changes in length. The movements of the roll 39 occurring in this way are utilized, when they extend beyond a middle zone of no control, to vary the speed of other dynamic instrumentalities in the train either preceding or succeeding it. Thus, the device comprising rolls 37, 38, and 39 (which I shall hereinafter refer to as a static tension take-up device) may be caused to control the speed either of the continuous puller hereinabove described, or of the mill hereinafter to be described. The operation of the static tension take-up device and the general features which go to make up its construction, are set forth more in detail in my co-pending application entitled Rolling under tension, referred to hereinabove.

The strip 42 next is carried to a mill shown in the drawing and comprising housings 46 and working rolls 47. While this is not a limitation upon my invention, yet, for the purpose of making drastic cold rolling reductions, and more particularly for rolling strip sheets into thin gauge metal, such as tin plate, I prefer to use small working rolls 47. The small working rolls, of course, are backed up by larger rolls 48, and the type of mill I have shown in my drawing is known as the four-high mill. The mill will be driven in any suitable manner, and in this type of mechanical organization will be of the reversible type, normally, since in reducing metal to thin gauges, more than one pass through the rolls is desired. Normally the mill and the rolling operations will be so adjusted as to reduce the strip sheet to finished gauge in three or five passes. The number of passes will preferably be uneven, since it will be desired to deliver the finished pieces on the side opposite to the side of its entry into the mill. I have shown but one rolling mill; but it will be clear that more than one or a train of cold mills, may be employed if desired.

Upon leaving the mill the strip goes through another static tension take-up device comprising appropriate framework, knee rolls 49, and a pull roll 50, preferably actuated in the same way as heretofore described, by a hydraulic cylinder 51 connected by a conduit 52 to an accumulator 53. I have shown in my drawing a pump 54 feeding both accumulators. It will be understood that I may use other means than a hydraulic cylinder for actuating the pull rolls of my static tension take-up devices, such as a system of cables and weights, for example.

While, beyond the static tension take-up device just referred to, it would be practicable to place another continuous puller and a reeling device or other take-up means, to which tensioning power does not have to be applied, and while this is within the scope of my invention, yet I have not found it necessary to do this, and prefer for economy's sake to employ a type of tight coiler. Inasmuch as the operation of my mill is to be as efficient from point of time as possible, I provide a tight coiler device of a type permitting an already formed coil to be unwound and removed while a new coil is being wound up under tension. Consequently, I have shown a base 55 upon which I pivot, by means of a shaft 56, a pair of arms 57 and 58 forming a cradle for two tight coiling mechanisms indicated respectively at 59 and 60. This cradle can be swung about by means of a small motor 61, and through a suitable drive 62, so as to position the driving head 63 of either of the tight coiling mechanisms in alignment with a clutch member 64. In Figure 1 a tight coiler spindle 59 is shown as connected by the clutch 64 to a shaft 65 which is driven by a motor 66 through suitable gears 67. Ordinarily in the operation of my system, the first static tension take-up device will be caused to control the speed of the mill motor, and the second static tension take-up device will be caused to control the speed of the tight coiler; the speed of the continuous puller shown in Figures 1 and 2 being the fundamental basis for the controlled speeds of the other dynamic instrumentalities in the train. The second static tension take-up device therefore acts to maintain constant tension in spite of sporadic variations in the operation of the final tight coiler. Since the final tight coiler is controlled in speed by the static tension take-up device, the power applied to the tight coiler is caused to vary in accordance with the diameter of the coil of metal formed on the tight coiler spindle. I have shown a coil 68 being wound up on the tight coiler spindle 59 while a coil 69 is being removed from the spindle 60 and coiled upon a spindle mechanism as at 70, to form a package of the metal suitable for shipment or storage. It will be understood, of course, that instead of forming a coil as at 70, the reduced strip may be cut apart into sheets by a suitable shear.

In the operation of my device, coils of metal from the hot mills are welded together end to end to form a large coil 12. At the start of all operations of the metal, an end of this coil is led through the continuous puller and the static tension device, then through the mill, through the next static tension device, and to the tight coiler to which the end thereof is affixed. The mechanism is started in operation and the strip rolled to very near its trailing end, leaving always sufficient of the metal to be caught by the pinch rolls 29 and 30. The deflector 36 is next dropped and the mill and other associated instrumentalities reversed, whereupon the strip moves in the opposite direction, and as it is fed through the pinch rolls 29 and 30, winds up on the friction coiler 19 to form a coil which I have indicated at 71. The strip in this way is rolled until near its leading end, leaving a portion, however, long enough to extend from the mill to the final tight coiler. In this way the piece is rolled backwardly and forwardly a sufficient number of times to bring about the desired reduction in gauge. During the rolling operation it is taken up alternately either upon the final tight coiler or upon the initial friction coiler.

When the piece has been reduced to gauge, it being assumed that the piece is finished by a forward pass in the mills, its trailing end will extend sufficiently to be caught with the pinch rolls 29 and 30, and the greater portion of the length of the strip will be wound upon the tight coiler 59 to form the coil 68. The strip will be clamped ahead of this coil and cut off, whereupon the cradle formed by the arms 57 and 58 will be rotated to bring the now empty tight coiler spindle 60 into position to be operatively connected with the driving shaft 65 by the clutch 64, and to bring the coil 68 in a position to be decoiled. In this first operation there will be an initial length of the leading end of the strip forming the coil 68, which will not be rolled. This can be cut off as scrap, or used for some other purpose; but end loss will not occur again in the operation of this system for reasons which will hereinafter be described. That is to say, after the rolling of the initial batch of material, no more end scrap loss will be encountered until it is necessary, for some reason or other, to dethread the material or to take the system down for repairs or replacements.

The next step will be to weld the trailing end of the strip extending through the rolls 29 and 30, to the leading end of a new supply of rolling material which, it will be understood, has been accumulated in the meantime upon the reel 12. This welding is done by means of the device 14. Any unrolled portion of the first strip will now lie to the left of the mill in Figures 1 and 2, and, when the mill is started up and the foregoing series of operations is repeated, will be rolled so that when the next supply of rolled stock is taken from the mill as aforesaid, all parts of it will be uniformly down to gauge. The system of operations hereinabove described is repeated for each batch of material. It will be observed that in my mechanism three distinct operations are going on at the same time: first, the formation of a supply of rolling material of great length and weight, formed by the welding together in the end of a plurality of strip sheets from the hot mills; second, the forward and reverse rolling of a preceding supply already so formed; and third, the decoiling or cutting apart into sheets of an already rolled supply of material.

During the course of the rolling, the continuous puller upon one side of the mill and the tight coiler upon the other side of the mill, act to exert tension upon the strip, which tension is of material assistance in rolling. By the use of tension I do not primarily refer to such minor amounts of tension as are useful in feeding the mill or mills and in reducing camber. Rather I prefer to use heavy tensions such as facilitate the reduction of the metal by the cold mills. The tension produced by the continuous puller and the tight coiler is maintained at a constant value by the static tension take-up devices, which act continuously to make the tension constant in spite of variations in the length of the strip between the several dynamic instrumentalities, and to control the speeds of these instrumentalities if variations greater than normal or accumulative variations occur. It will be clear that the continuous puller and the tight coiler act on succeeding passes respectively as brakes and as pullers, and vice versa.

Modifications may be made in my invention without departing from the spirit thereof.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent, is:—

1. In a rolling apparatus, the combination of a decoiler, a welder, means for accumulating large coils formed by welding, a welder, a coiler, a mill, and a coiler, in the order named, and means intermediate at least said first coiler and said mill for producing tension on the strip being rolled.

2. In a rolling apparatus, the combination of a decoiler, a welder, means for accumulating large coils formed by welding, a welder, a coiler, a mill, and a coiler, in the order named, means intermediate at least said first coiler and said mill for producing tension on the strip being rolled, and means on either side of said mill for maintaining the tension of the strip constantly at predetermined values.

3. In a tension rolling apparatus for metal strip, the combination in the order named of a coiling device acting as an accumulator for strip, a continuous puller for exerting tension on the strip, a mill, and a coiling device adapted to exert tension on the strip.

4. In a tension rolling apparatus for metal strip, the combination of a non-tensioning coiler, a continuous puller for exerting tension on the strip, a mill, a second continuous puller, and a coiler, in the order named.

5. In a tension rolling apparatus for metal strip, the combination of a non-tensioning coiler, a continuous puller for exerting tension on the strip, a static tension take-up device for maintaining said tension constant in spite of the variations of elongation, a mill for elongating the strip, a second static tension take-up device, and a tight coiler for exerting tension on the strip, in the order named.

6. In a tension rolling apparatus, the combination of a means for holding a large supply of strip rolling material in coiled form, welding means for joining said supply to the end of a previously rolled supply, a take-up coiler for said supply, a continuous puller for exerting tension thereon, a mill for elongating said supply and a tight coiler for exerting tension thereon, in the order named.

7. In a tension rolling apparatus, the combination of a means for holding a large supply of strip rolling material in coiled form, welding means for joining said supply to the end of a previously rolled supply, a take-up coiler for holding said joined supply, a continuous puller for exerting tension thereon, a mill for elongating said supply, and a tight coiler for exerting tension thereon, in the order named, said tight coiler comprising interspaced tight coiler spindles, and means for operatively connecting said spindles to a drive alternatively so that one of said spindles may act as a tight coiler, while a rolled supply of material is being removed from said other spindle.

8. In a tension rolling apparatus, the combination of a decoiler for coils of strip material, a welder for joining the ends of strips, means for accumulating large coils of strip formed by the welding of strips together, a second welder for joining an end of said large coils to an end of a supply of strip previously rolled, a coiler acting as an accumulator for a large supply of strip rolling material constituting such large coils, a mill for elongating said supply and a coiler located on the opposite side of said mill, in the order named.

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